1 (i)	N(352, …) Variance = 2.9	**B1** **B1**	[2]	no recovery in (ii) for each B mark accept sd = √ 2.9 = 1.70(29) stated
(ii)	$\frac{354-352}{\sqrt{2.9}}$ (= 1.174) 1 – Φ(‘1.174’) = 0.120 (3 sf)	**M1** **M1** **A1**	[3]	with their mean and var Or $\frac{354.05-352}{\sqrt{2.9}}$ or correct restart (= 1.204) (accept sd/var mix)1 – Φ(‘1.204’) = 0.114 (3 sf) Incorrect cc can score M1M1A0
Total			**[5]**	
2	($\Phi^{-1}(0.99)$ =) 2.326 seen N(λ, λ) seen or implied $\frac{55.5-\lambda}{\sqrt{\lambda}}$ = + “2.326” λ + “2.326” $\sqrt{\lambda}$ – 55.5 = 0 $\sqrt{\lambda} = \frac{-\text{“}2.326\text{”} \pm \sqrt{\text{“}2.326\text{”}^2 + 4 \times 55.5}}{2}$ (= 6.377.. or – 8.703..)) λ = 40.7 (3 sf)	**B1** **M1** **M1** **M1** **A1**	[5]	must be Φ^{-1}, not Φ allow with wrong or no cc & Φ(0.99) (= 0.8389) must = “ z “ or attempt at z (0.99 / 0.01 M0) for correct method of solving their quad in √λ and squaring to find λ cao, one ans only Without cc, λ = 40.2: lose final A1
Total			**[5]**	
3 (i)	0.4 or 2/5 or 26/65	**B1**	[1]	no recovery in (ii) for the B mark
(ii)	“ 0.4 ” + $z \times \sqrt{\frac{0.4 \times 0.6}{65}}$ = 0.516 oe $z = \left(0.116 \times \sqrt{\frac{65}{0.4 \times 0.6}}\right) = 1.909$ (Φ(‘1.909’) = 0.97(18)) 2 (‘0.97’ – 1) α = 94	**M1** **A1** **M1** **A1**	[4]	or “ 0.4 “ – $z \times \sqrt{\frac{0.4 \times 0.6}{65}}$ = 0.284 or $z \times \sqrt{\frac{0.4 \times 0.6}{65}}$ = 0.116 oe for fully correct method to find α from their z allow 94.36 or 94.4 or 94.374
Total			**[5]**	

4 (i)	$k\int_{-2}^{2}(4-x^2)\mathrm{d}x = 1$	**M1**		attempt Integral f(x) = 1, ignore limits
	$k[4x - \frac{x^3}{3}]_{-2}^{2} = 1$	**A1**		correct integration & limits
	$\left(k\left(8-\frac{8}{3}-\left(-8-\left(-\frac{8}{3}\right)=1\right)\right)\right)$			
	$k \times \frac{32}{3} = 1$ oe Not e.g. $k\times 10.7 = k$			
	$k = \frac{3}{32}$ **AG**	**A1**	[3]	exact answer correctly found
(ii)	Inverted parabola, vertex on y axis	**B1**		parabola must finish on x axis at ± 2, labelled (ignore markings on y axis)
	E(X) = 0	**B1**	[2]	
(iii)	$\frac{3}{32}\int_{-2}^{1}(4-x^2)\mathrm{d}x$	**M1**		or $1 - \frac{3}{32}\int_{1}^{2}(4-x^2)\mathrm{d}x$ ignore limits
	$\frac{3}{32}[4x - \frac{x^3}{3}]_{-2}^{1}$	**A1**		or $1 - \frac{3}{32}[4x - \frac{x^3}{3}]_{1}^{2}$ correct integration and correct limits
	$\frac{3}{32}(4 - \frac{1}{3} - (-8 - (-\frac{8}{3})))$			$= 1 - \frac{3}{32}(8 - \frac{8}{3} - (4 - \frac{1}{3})$
	$= \frac{27}{32}$ or 0.844 (3 sf)	**A1**	[3]	
Total			**[8]**	

5 (a)	$\lambda = 4.5$ $e^{-4.5}$ (= 0.011109) $\left(\frac{99}{100}\right)^{450}$ (= 0.010860) $\left(\frac{'0.011109' - '0.010860'}{'0.010860'} \times 100\right)$ = 2.29% (3 sf)	**B1** **M1** **M1** **A1**	 [4]	 alone allow any λ
(b)	H_0: P(6) = $\frac{1}{6}$ or $p = \frac{1}{6}$ H_1: P(6) < $\frac{1}{6}$ or $p < \frac{1}{6}$	**B1**		Both needed
	$\left(\frac{5}{6}\right)^{25} + 25\left(\frac{5}{6}\right)^{24} \times \frac{1}{6} + {}^{25}C_2\left(\frac{5}{6}\right)^{23} \times \left(\frac{1}{6}\right)^2$	**M1**		allow one error (extra term / missing term / incorrect term) CR method: attempt at least P(0) and P(0 and 1) (0.010... and 0.06... < 0.1)
	= 0.189 (3 sf)	**A1**		CR is 0,1 and must see 0.189 for A1
	comp 0.1	**M1**		valid comp '0.189' with 0.1 oe valid comparison of 2 with CR
	No reason to believe die biased	**A1**	[5]	correct conclusion, √ their 0.189 no contradictions
Total			**[9]**	
6 (i)	Ho: $\mu = 2.60$ H_1: $\mu > 2.60$	**B1**		allow pop mean, not just 'mean'
	$\pm \frac{2.64 - 2.6}{0.2 \div \sqrt{75}}$	**M1**		
	= ± 1.732	**A1**		accept ± 1.73 (3 sf)
	'1.732' > 1.645 Reject Ho. There is evidence that μ has increased	**B1** √	[4]	valid comparison with 1.645 (or 0.0416 < 0.05) and correct conclusion √ their 1.732 no contradictions (or CV method x_{crit} = 2.638 M1A1 comp 2.64 > 2.638 and concln B1 √) SR two tail test, using 1.96 (or using 0.025) can score B0M1A1B1ft max 3/4

(ii)	$\frac{x-2.6}{0.2\div\sqrt{75}} = 1.645$ $(x = 2.638)$ $\pm\frac{'2.638'-2.68}{0.2\div\sqrt{75}}$ $= \pm 1.819$ $\Phi('-1.819') = 1 - \Phi('1.819')$ $= 0.0345$ or 0.0344	M1 M1 A1 M1 A1	[5]	for standardising with their " 2.638 " using 2.68 accept 1.82 (3 sf) indep M mark, calculate correct area / prob consistent with their working
Total			**[9]**	
7 (i)	est $\mu = 2.087$ est $\sigma^2 = \frac{100}{99}\left(\frac{435.57}{100} - 2.087^2\right)$ $= 0.000132(3232)$ or $131/990000$	B1 M1 A1	[3]	allow 2.09 $1/99\,(435.57 - 208.7^2/100)$ without $\frac{100}{99}$: 0.000131 M0A0
(ii)	$E(Y-X) = 2.12 - 2.087$ (= 0.033) $Var(Y-X) = 0.000144 + '0.00013232'$ $= 0.000276(32)$ $\frac{0.01-'0.033'}{\sqrt{'0.00027632'}}$ $(= -1.384)$ $\Phi('-1.384') = 1 - \Phi('1.384')$ $= 0.0832$	B1 M1 A1 M1 M1 A1	[6]	or 2.12 – 2.087 – 0.01 for Y – X – 0.01 < 0 allow 2.09 for 2.087 or $\sqrt{(0.012^2 + '0.00013232')}$ M1 = 0.016623 A1 √their $E(Y-X)$ & $Var(Y-X)$ var must be a combination of the two vars correct area / prob consistent with their working SR use of biased var (0.000131) in (i) and (ii) scores in (ii) B1M1 A1 for 0.000275 and M1M1 A1 for 0.0827 (6 / 6 available)
Total			**[9]**	
	Total for paper		**[50]**	